Space Weather Technical Forecast

Issued on Friday, 31 December 2021 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor storm on 01 January.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was low, with one C9.8 flare observed at 31/0654UTC from the region of AR2918 (Bxo/beta) in the northwest quadrant. There appears to have been a filament eruption associated with this flare, although analysis suggests that this may have been reabsorbed. There are four sunspot regions on the disc in total, with AR2916 (Eai/beta) large but stable with no recent flare activity. AR2918, which was responsible for the C-class flare, had been following a declining trend, with only two spots and no penumbra. The other two regions are benign alpha spots. A prominence lifted from the southwest of the Sun at around 31/0700UTC and is becoming emerging from behind the occulting disc on both LASCO and STEREO imagery. As this is potentially Earth-directed a detailed analysis will be made, once the required imagery becomes available.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1, started the period at around 500km/s as the Earth connected with the high speed stream from coronal hole 39. The winds have since steadily declined to 420km/s by the end of the period. Density has been steady and around average for much of the period with only minor fluctuations. Total magnetic field strength has been weak, but with a rising trend over the last two hours of the period. The north-south component, Bz, has varied weakly. Phi angle was mainly weakly positive (away from the Sun). Geomagnetic activity has been Quiet throughout. (Kp1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at background levels. High energy (greater than 2MeV) electron flux has been at background to moderate levels. Electron fluence was well below the Active (1e8 integrated pfu) threshold. Observed fluence at 31/0000UTC was 3.65e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Low or very low solar activity is expected, with a slight chance of M-class flares from either 2916 or 2918.

Solar Wind / Geomagnetic Activity: No CMEs are currently expected in this forecast period. The current high speed stream from coronal hole 39 is forecast to decline towards background on 31 December. A high speed stream of 500km/s from coronal hole 40 is then expected to connect with the Earth on 01 January. Speeds are likely to remain at this level through 01 and 02 January, but then start declining on day 3. Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a risk of Active or G1/Minor Storm intervals on day 2 due to the onset of the high speed stream.

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Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, albeit with a very slight chance of S1 due to the potential contained within the two most significant sunspot regions. High energy electron flux values are expected to remain below the high (1e3pfu) threshold on days 1 and 2, with a slight chance of increasing above the threshold on days 3 and 4 on diurnal peaks. Electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, but with an increasing trend on 02 and 03 January.

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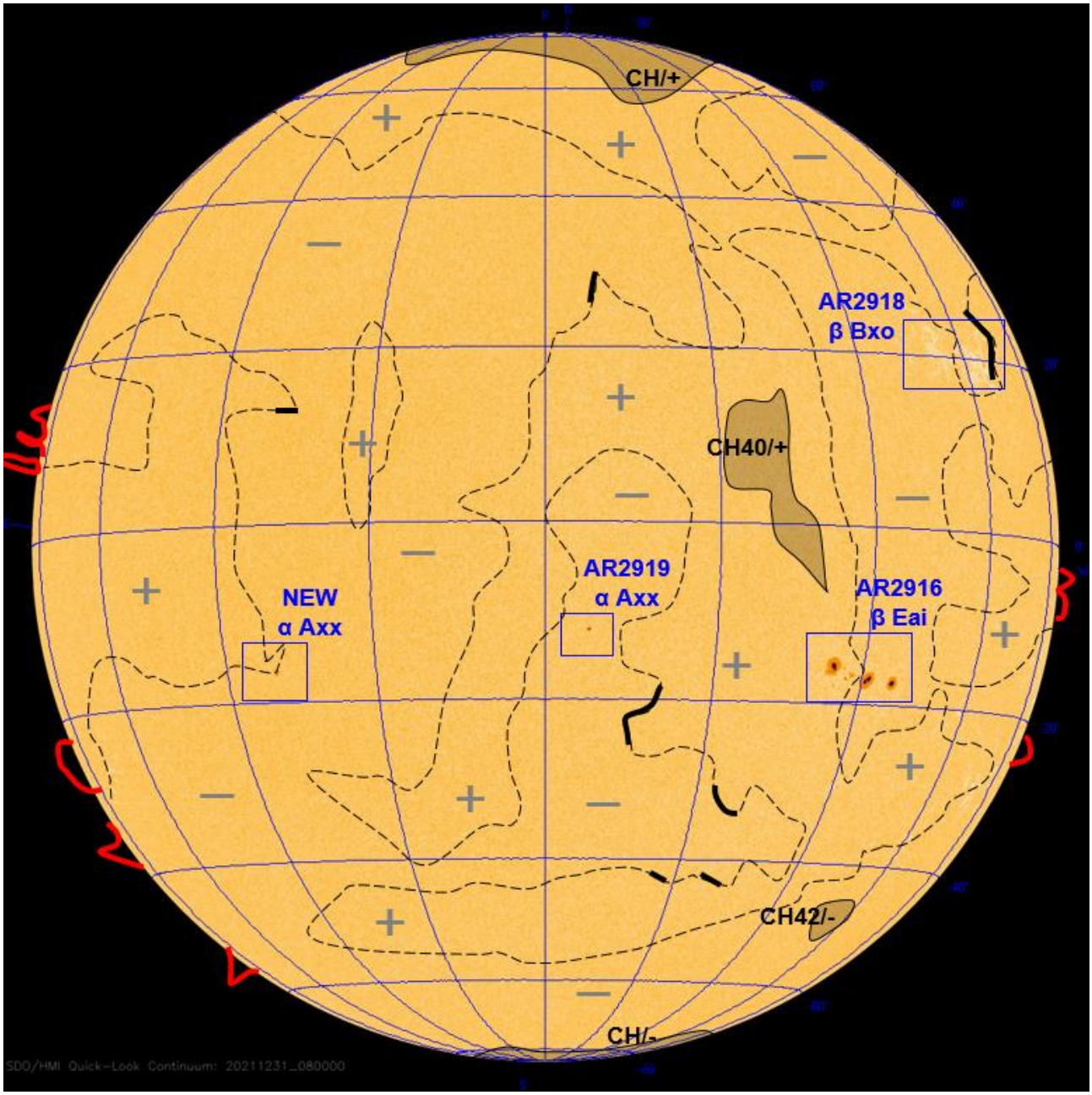
Figure 1. Solar Analysis Valid 31/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are currently in the forecast.

The high speed stream from coronal hole 39 is currently affecting the Earth, and is on a declining trend as the feature rotates towards the western limb. Coronal hole 40 is then expected to connect with the Earth on day 2 (01 January), with speeds of around 500km/s forecast, based on persistence and limited STEREO A data. A decline in speed is then likely later on day 3 and through day 4.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through much of the period, with isolated Active or G1/Minor Storm intervals on day 2 due to the onset of the high speed stream.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected

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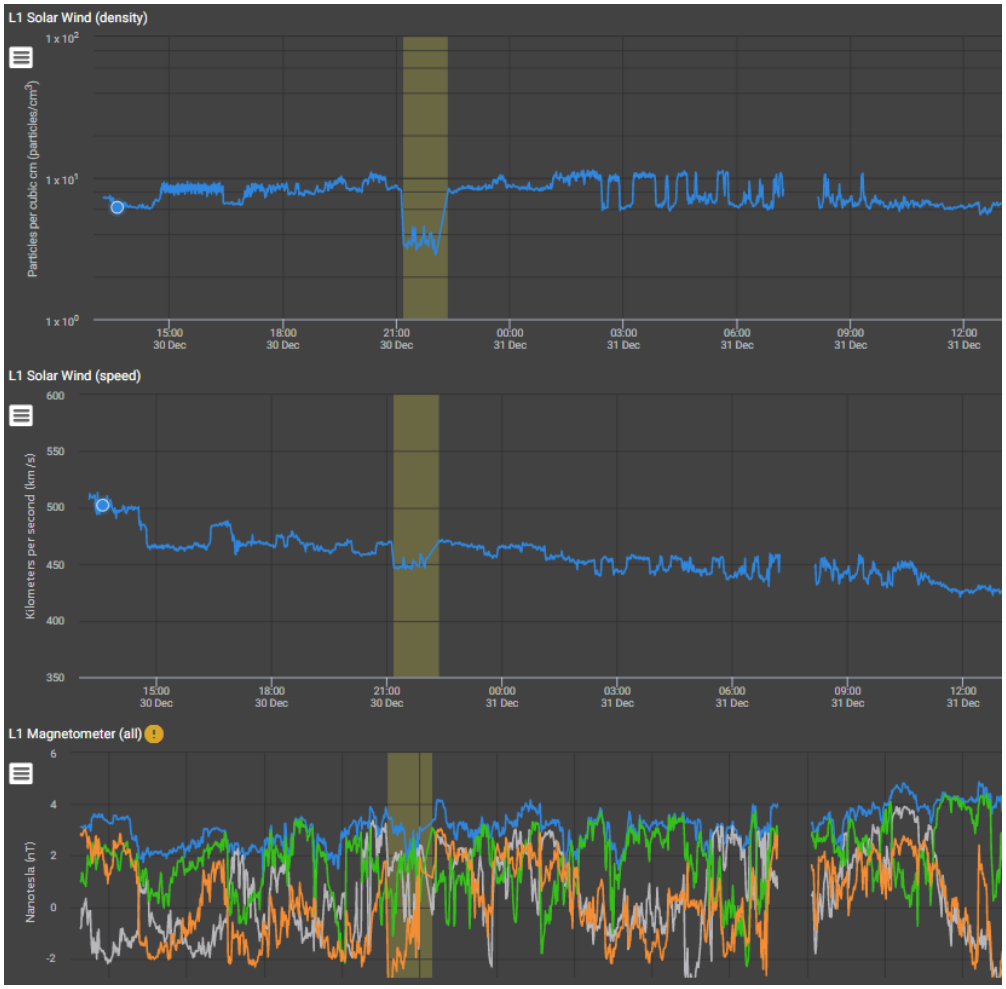
Figure 2: 24 hour solar wind parameters from DSCOVR and ACE



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Radio Blackouts - X-Ray Flares:

Solar activity is expected to be low or very low over the next four days with only large and stable or small and benign sunspots on the visible disc.

AR2916 (Eai/beta) is the largest region, but has not produced any significant activity through the last 48 hours. AR2918 (Bxo/beta) is following a declining trend, but recent produced a C9.8 which suggests the possibility of significant flare potential as it rotates toward the northwestern horizon. The remaining two regions are both small unipolar spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	10	10
Very Active	R3 to R5 X Class	No	3	3	1	1

Figure 3: AR2916 (Eai/Beta) in the southwest quadrant showing very little development.

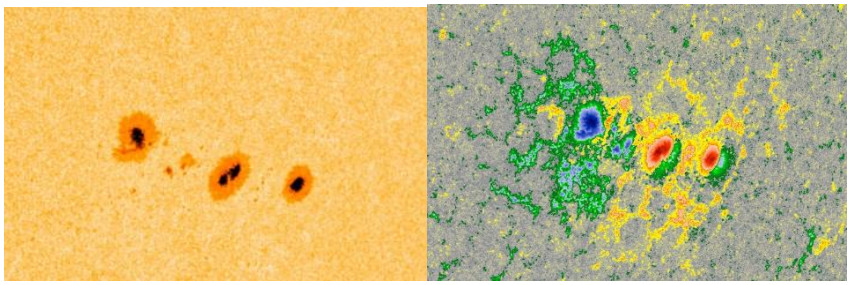
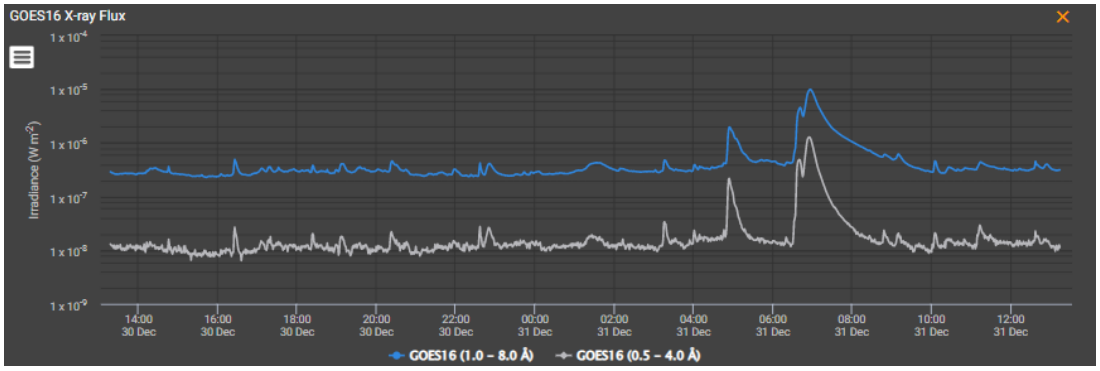


Figure 4: GOES16 X-ray flux with the C9.8 flare from AR2918 at 0656UTC.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist as such. Despite the apparent stability, 2916 and 2918 continue to be monitored for potential radiation storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is expected to be at background levels and may be limited by any geomagnetic activity due to the onset of the high speed stream from coronal hole 40 on 01 January. Electron flux values are then likely to increase as the wind strengthens, with high (1e3pfu) levels possible through days 3 and 4.

Electron fluence values are forecast to remain below the Active (1e8 integrated pfu) threshold, but with a rising trend on days 3 and 4.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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